FASD Costs: Evidence from Hawaii Medicaid Data

Mouhcine Guettabi [1*] Bridget L. Hanson [1,†] Rebecca R. Porter [1,‡]

[1] Institute of Social and Economic Research, University of Alaska Anchorage

November 26, 2019

Abstract

We use information from Hawaii Medicaid data for individuals who have at least one FASD-related condition. The total spending for these individuals between 2011 and 2015 was $460,515,584. Of that total, more than $32 million is directly associated with FASD-related visits/codes. We find that the average FASD-related visit costs $121, which is more expensive than the average medicaid visit. We also find that the frequency of FASD-related visits increases with age. We find evidence that the number of initial conditions is positively associated with the number of visits and accumulated medical costs and that 20% of the patients are responsible for 85.85% of the total spending.

Keywords: Fetal Alcohol Spectrum disorder; Medicaid; Health Costs.

JEL Classification: I11; I18

Acknowledgement: This paper was supported by the United States Department of Health and Human Services, Centers for Disease Control and Prevention Cooperative Agreement 5NU01DD001143. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the authors' institution.

*Associate Professor of Economics. Email: mguettabi@alaska.edu

†Research Associate Professor. Email:blhanson4@alaska.edu

‡Project Manager. Email: rrporter2@alaska.edu

Contents

1 What are FASDs?

Fetal alcohol spectrum disorders (FASDs), a collection of permanent yet preventable developmental disabilities and birth defects resulting from prenatal alcohol exposure, are associated with substantial costs (Popova et al., 2017). FASDs have been conservatively estimated to affect one in 20 U.S. children (May et al., 2018). However, as explained in Chasnoff et al. (2015), many FASD cases are often missed or misdiagnosed because of unknown or unconfirmed prenatal alcohol exposure, lack of universal diagnostic guidelines, and a high prevalence of comorbidities. Over four hundred co-morbid conditions have been found to occur among individuals with FASD (Popova et al., 2016). This high number of comorbid conidtions is due to the potent teratogenic effects of alcohol, which creates potential for abnormal fetal development and produces lifelong health consequences Hong and Krauss (2017). Further, people living with FASD present with wide-ranging needs spanning across systems of care including social services, criminal justice, education, medicine, and mental health (Jirikowic et al., 2010). Sizeable financial and social impacts related to FASDs have cut across global, regional, and local communities (Lange et al., 2017).

1.1 FASDs are preventable

FASDs are preventable if a fetus is not exposed to alcohol. Therefore, prevention efforts target alcohol consumption among people who are or could become pregnant. One cost-effective method for FASD prevention is alcohol screening and brief intervention (SBI). The U.S. Preventive Services Task Force (USPSTF) recommends alcohol SBI for unhealthy alcohol use as a population-wide clinical preventive service for all adults in primary care, including those who are or could become pregnant (O'Connor, Perdue, Senger, Rushkin, Patnode, Bean, & Jonas, 2018). Despite sufficient efficacy evidence, overall uptake of alcohol SBI in clinical settings lags (Babor et al., 2007; Désy and Perhats, 2008; Lewis et al., 2014). Local efforts to address challenges associated with alcohol SBI implementation may provide scalable information that can be used to advance regional and national FASD prevention efforts (Rieckmann et al., 2018).

Since 2007, the State of Hawaii has been addressing FASD prevention, including training and implementation efforts, to increase maternal screening for alcohol use during pregnancy. However, inadequate infrastructure and limited resources have impeded progress. Policy-level changes to improve universal alcohol SBI, particularly among pregnant women, have been highlighted as necessary to build a strategic, state-wide comprehensive FASD prevention plan (Onoye and Thompson, 2017).

2 Method

2.1 How do we quantify costs?

The goal of our analysis is to understand how FASD is associated with health care visits and spending for Hawaii Medicaid recipients. In order to quantify costs associated with FASDs, we examine Hawaii Medicaid data with visits from 2011-2015. We use inclusion criteria of patients less than 19 years old with one or more FASD-related visit. To identify these visits, we rely on diagnosis codes from the American Academy of Pediatrics, who has a comprehensive list of diagnoses associated with FASDs from both ICD-9 and ICD-10.[1] For each visit, we have diagnosis code, procedure code, amount (in $) billed, and amount (in $) paid.

If an individual had an FASD-related diagnosis, then we have that person's universe of visits and costs for the 5 years between 2011 and 2015 during which the individual was under the age of 19. For the rest of the paper, we refer to the first FASD-related diagnosis occurring in the available data for each individual (i.e., inclusion criteria of an FASD-related condition) as "initial FASD diagnosis."

It is important to note that the period for inclusion for initial diagnosis of an FASD-related condition is between 2009 and 2015. While all the analysis is broadly interested in the visits and expenditures for FASDs, there are only 10 people who have an initial diagnosis of fetal alcohol syndrome (FAS; code 76071). This is unsurprising as FAS is only a small subset of the FASD umbrella and conditions under this umbrella are often undiagnosed.

Annualized results are based on 13,557 which is the average number of individuals across the five years in our sample. Our sample has approximately 9% of Medicaid beneficiaries ages 0-18. In total, we have records for 18,711 individuals between the ages of 0 and 18. Of those, we have 1,198 individuals with 0 expenses after merging because these individuals do not have a cohort number. Therefore our analysis will focus on the 17,513 individuals who we observe having at least one medical visit during the study period of 2011-2015.

Given our goal in this analysis of understanding the costs associated with FASDs in the Hawaii Medicaid population, we approach the question by examining the overall spending of people who meet our initial inclusion criteria as well as focus on specific diagnoses that are most likely to be linked to FASD.

3 Summary statistics

Below, we list some basic descriptive statistics regarding the characteristics of the Medicaid recipients for whom we have data. Our sample is 60.7% male and 39.3% female. The largest three groups by race are Native Hawaiian (23.2%), white (22.2%), and Filipino (15.1%). In Table 3, we show the distribution of visits and spending for all visits and FASD-related visits. In Table 4, we decompose our sample by the number of original diagnoses identified for each individual. We see that the majority of individuals (82.7%) have one FASD-related diagnosis, and only 750 (4.3%) with 3 or more diagnoses.

3.1 Hawaii's childhood Medicaid population

In FY2012, Hawaii Medicaid covered 107,000 children in Hawaii, with annual costs per child averaging $2,015 (American Academy of Pediatrics, 2017). At the end of calendar year 2015, Hawaii Medicaid had 151,173 beneficiaries 0-18 years of age. In our sample of individuals with a FASD-related diagnosis, for the same calendar year, 13,167 individuals are included. Therefore, our sample represents 8.8% of Hawaii's childhood Medicaid population.

[1] See Appendix 1 for a list of codes included as inclusion criteria.

Table 1: Number of patients by race and gender

Race	Female	Male	Total
Native Hawaiian	1,435	2,624	4,059
White	1,484	2,407	3,891
Filipino	1,031	1,672	2,703
Pacific Islander	492	846	1,338
Other Asian	898	1,451	2,349
Other	819	1,217	2,036
Unknown	492	645	1,137
Total	6,651	10,862	17,513

Table 2: Charges by visit and annually per individual

Year	*M* per visit	*SD* per visit	*M* total	*SD* total
Charges by year at the individual level				
2011	110.91	307.28	6,502.28	32,847.55
2012	108.77	336.69	5,996.10	46,227.22
2013	110.11	394.79	6,867.62	42,452.16
2014	110.63	423.27	7,385.58	43,999.51
2015	95.69	342.00	7,192.87	55,439.74
Average	107.30	364.71	5,427.15	40,149.71
FASD charges by year at the individual level				
2011	152.07	658.87	1,377.14	7,308.036
2012	130.09	536.11	1,328.03	7,027.83
2013	113.70	532.16	1,184.94	6,316.76
2014	110.42	442.65	1,355.57	9,595.73
2015	105.18	709.87	1,331.67	7,885.14
Average	121.37	582.84	1,313.77	7,723.91

Notes: *M* per visit refers to the average number of visits at the individual level, *SD* per visit refers to the standard deviation of number of visits at the individual level. *M* total refers to average total spending per year, and *SD* total refers to the standard deviation of the average total spending.

3.2 How often did people visit the doctor?

In the table below, we examine the distribution of overall visits, FASD-related visits, and the corresponding spending. We find that, on average, the individuals in our sample average 19.45 visits a year with an average cost of $107.30. When looking specifically at FASD-related visits, we find that they averaged 7.03 visits per year which accounts for 36% of all visits but there is considerable variation across ages. We also note that the number of FASD-related visits increase with age. Additionally, the average costs of an FASD-related visit is $121.37 which is higher than the average visit of any kind.

Table 3: Frequency of yearly visits and spending by age

Age	Frequency of visits	Frequency of FASD visits	Average charge	Average FASD charge
0	21.37	2.42	395.6	77.71
1	19.66	4.26	95.86	91.29
2	16.37	5.68	68.56	54.58
3	14.68	5.97	65.91	53.35
4	15.17	4.35	64.13	90.30
5	16.89	5.36	59.04	95.10
6	18.04	7.06	61.78	90.99
7	19.01	7.94	63.93	76.44
8	20.72	8.10	70.93	81.62
9	21.44	8.32	75.70	101.98
10	21.29	8.04	87.02	109.20
11	21.08	8.40	91.82	125.31
12	20.76	8.34	105.79	148.91
13	20.14	8.16	104.56	152.69
14	21.42	8.43	114.02	161.63
15	23.19	8.86	137.77	213.75
16	24.72	9.78	159.45	266.24
17	25.19	9.23	170.85	255.58
18	23.90	9.24	157.51	214.20
Average	19.45	7.03	107.30	121.37

Table 4: Distribution of the number of diagnoses

Number FASD-related diagnoses	Number of individuals
1	14,478
2	2,285
3	537
4	147
5	42
6	21
7	3
Total	17,513

Table 5: Age at initial diagnosis

Age at initial diagnosis	Number of patients	Share
0	3,414	19.49%
1	1,914	10.93%
2	1,757	10.03%
3	535	3.05%
4	588	3.36%
5	684	3.91%
6	907	5.18%
7	913	5.21%
8	894	5.10%
9	769	4.39%
10	661	3.77%
11	638	3.64%
12	642	3.67%
13	630	3.60%
14	620	3.54%
15	574	3.28%
16	591	3.37%
17	446	2.55%
18	336	1.92%
Total	17,513	

4 Overall spending, FASD-related spending, and visits

First, we ignore initial diagnoses and describe the overall spending and the spending associated with specific FASD-related visits for all individuals between 2011 and 2015. In Table 6, we show that the total spending for the 5 years of data is $460 million for the 17,513 individuals who were included between 2011 and 2015. Of that spending, $32.8 million is directly associated with visits that had a FASD-related code. In Table 7, we break down the FASD-related spending by diagnosis to better understand where most of this spending is occurring. In aggregate, attention-deficit/hyperactivity disorder (ADHD) expenditures accounted for between 23.15% and 40%. Complex trauma accounts for the second highest expenditures.

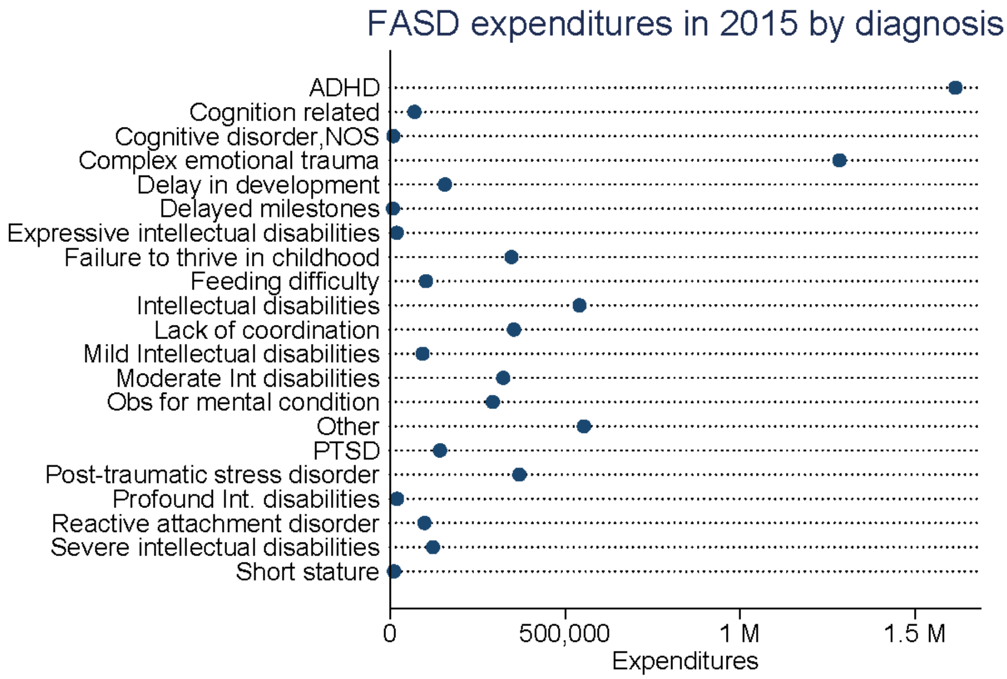
Table 6: Spending by year

Year	All spending	Only FASD spending	Share attributed to FASD
2011	82,982,136	6,181,993	7.45%
2012	82,146,600	6,552,524	7.98%
2013	96,689,240	6,095,368	6.30%
2014	103,989,048	6,994,743	6.73%
2015	94,708,560.0	6,981,686	7.37%
Total	460,515,584	32,806,315	7.12%

Table 7: Distribution of FASD-related spending by year and diagnostic code

Diagnosis	2011	2012	2013	2014	2015	Total
Attention-deficit/hyperactivity disorder	2,469,104	2,360,382	2,408,326	2,598,420	1,782,780	11,619,012
Complex emotional trauma	1,745,007	2,179,472	1,605,081	1,558,747	2,337,790	9,426,097
Failure to thrive in childhood	265,397	331,256	337,741	1,061,049	392,494	2,387,937
Lack of coordination	346,852	242,123	228,726	303,012	386,268	1,506,981
Reactive attachment disorder	389,211	253,639	231,183	145,505	131,430	1,150,968
Observation for mental condition	144,912	193,321	201,347	173,861	316,071	1,029,512
Delay in development	230,447	175,550	172,570	208,349	179,457	966,373
Feeding difficulty	188,532	190,676	182,932	175,706	139,262	877,108
Cognition-related	2,493	266,693	241,300	171,172	70,136	751,794
Moderate intellectual disabilities	50,392	40,199	137,046	97,197	646,223	971,057
Severe intellectual disabilities	52,954	17,701	100,646	88,956	245,093	505,350
Mild intellectual disabilities	47,475	25,620	26,624	90,455	149,436	339,610
Expressive language disorder	58,778	60,892	41,544	40,979	19,294	221,487
Cognitive disorder, NOS	18,101	35,747	18,810	89,990	9,455	172,103
Delayed milestones	32,705	46,179	39,903	28,158	8,526	155,471
Profound intellectual disabilities	37,515	27,610	21,017	29,888	20,234	136,264
Short stature	23,374	20,580	21,473	23,091	11,676	100,194
Other diagnoses (combined)	78,736	84,875	79,092	110,203	553,577	906,483
	6,181,992	**6,552,524**	**6,095,369**	**6,994,743**	**6,981,686**	**32,806,314**

Figure 1: FASD-related expenditures by diagnosis in 2015



In Table 8, we assess the frequency of visits associated with each of the main diagnostic codes. Unsurprisingly, the two codes responsible for the highest aggregate visits are the ones with the highest expenditures. This indicates that these codes are very prevalent but not necessarily the most expensive ones.

Note: While, the most significant overall spending is associated with ADHD, it is simply due to the high number of individuals who have those visits and not because the visits are expensive.

Table 8: Distribution of FASD-related visits by year and diagnosis

Diagnosis	**2011**	**2012**	**2013**	**2014**	**2015**
Attention-deficit/hyperactivity disorder	365	365	365	364	273
Complex emotional trauma	364	363	360	363	271
Failure to thrive in childhood	331	340	334	352	268
Reactive attachment disorder	351	338	339	328	261
Delay in development	301	308	309	322	266
Feeding difficulty	284	304	309	334	257
Moderate intellectual disabilities	254	242	310	283	264
Expressive language disorder	283	259	270	265	179
Observation for mental condition	184	240	230	266	232
Delayed milestones	239	263	282	243	116
Mild intellectual disabilities	267	198	181	271	213
Severe intellectual disabilities	180	173	274	227	170
Short stature	174	185	194	202	149
Lack of coordination	147	179	225	223	120
Language disorder	160	188	185	180	157
Severe intellectual disabilities	211	103	138	221	145
Developmental delay	93	173	172	149	55
Delayed milestones	153	132	118	141	98
Post-traumatic stress disorder	108	130	106	151	100
Profound intellectual disabilities	63	82	115	113	88
Short stature	56	76	75	99	82
Mental or behavioral problem	43	50	77	78	72
Disorder of written expression	36	40	57	32	36
Mood disorder	49	34	33	23	47
Mathematics disorder			17	151	6
Observation for other suspected condition	23	40	46	35	28
Hyperkinesis with developmental delay	29	53	57	13	5
Symptoms involving cognition	12	39	56	34	13
Other categories(combined)	78	101	127	150	1,650
All	**4,838**	**4,998**	**5,361**	**5,613**	**5,621**

5 Frequent initial diagnoses

As Table 4 shows, most individuals are included in the dataset due to having only one FASD-related condition that appears in the available data. We have 14,478 individuals with one FASD-related diagnosis, 2,285 with 2 diagnoses, 537 individuals with 3 diagnoses, 147 individuals with 4 diagnoses, 42 individuals with 5 diagnoses, 21 individuals with 6 diagnoses, and 3 individuals with 7 diagnoses. Rather than simply examining the visits and expenditures for the entire sample, we now turn our attention to the initial diagnoses- inclusion criteria- and how they influence future visits, spending, and general behavior. We focus on individuals who had only one FASD-related diagnosis to simplify the attribution process. We see from Table 9 that attention-deficit/hyperactivity disorder is by far the most prevalent diagnosis (4,405) followed by failure to thrive in childhood (1,942), delay in development (1,508), and complex emotional trauma (1,064). As we described previously, there are only 10 people who have an initial diagnosis of fetal alcohol syndrome (FAS). This means that the majority of our sample has diagnoses that fall under the umbrella of FASDs but have not been diagnosed with FAS, the most involved form of FASD.

Table 9: Most frequent FASD-related diagnosis for individuals with only one FASD-related code

Diagnosis	**Number of individuals**
Attention-deficit/hyperactivity disorder	4,405
Failure to thrive in childhood	1,942
Delay in development, unspecified	1,508
Complex emotional trauma (also PTSD)	1,064
Feeding difficulty and mismanagement	798
Expressive language disorder	604
Short stature	519
Problems with communication	516
Delayed milestones	378
Underweight	350
Observation for suspected mental condition	332
Dysmorphic Features	284
Mental or behavioral problem, unspecified	229
Lack of coordination or use for hypotonia (unspecified)	208
Lack of normal physiological development, unspecified	153
Reactive attachment disorder	134
Moderate intellectual disabilities	126
Observation for other suspected condition (neonatal period)	122
Other categories (combined)	806
All	14,478

5.1 Are there differences in future expenditures based on initial codes?

Starting with Table 10, we break down the average yearly spending by initial diagnosis. There is considerable heterogeneity in the amount of money spent on medical visits by code. We find that the most prevalent diagnoses are not the most expensive ones; for example, attention-deficit/hyperactivity disorder averages only \$5,675 per year while central nervous system disorder averages \$83,484, despite only six individuals diagnosed with it. The three diagnosis averaging more than \$100,000 were severe intellectual disabilities, feeding difficulties, and lack of normal physiological development. Fetal alcohol syndrome averaged \$4,504.

Table 10: Average yearly expenditures by initial diagnosis

Diagnostic name	**2011**	**2012**	**2013**	**2014**	**2015**
Obs for other condition	30,533	40,614	47,277	222,670	62,751
Mild intellectual disabilities	20,737	12,790	12,710	11,961	11,791
Problems with learning	1,210	737	7,154	5,137	1,127
Problems with communication	5,126	2,243	3,169	4,557	5,161
Mental or behavioral problem	2,525	2,689	2,842	5,570	6,640
Cognitive disorder, NOS	39,487	3,387	15,836	8,498	26,671
Hyperkinesis with dev. delay	10,719	4,605	8,320	2,037	3,131
Disorder of written expression	2,177	1,693	1,820	1,680	1,353
Developmental delay, mixed	40,103	32,027	56,555	39,414	4,002
Delay in Development, unspecified	15,791	12,178	20,566	11,802	12,511
Moderate intellectual disabilities	26,912	20,454	23,433	22,310	19,315
Severe intellectual disabilities	161,437	66,517	36,094	44,841	213,106
Profound intellectual disabilities	116,825	32,257	41,652	38,073	150,090
CNS disorder, NOS	3,508	54,741	109,187	122,548	127,435
Behavioral problems, other	1,651	1,262	2,358	1,564	1,180
Obs for suspected mental condition	7,386	5,483	6,452	6,837	17,454
Maternal complication	1,849	1,485	3,461	1,548	4,957
Lack of coordination	88,394	22,146	127,741	109,314	40,858
Feeding difficulty	126,757	92,183	151,612	101,791	185,549
Dysmorphic Features	45,217	9,764	9,586	24,758	10,573
Mood disorder	3,905	4,652	4,534	10,224	4,126
Complex emotional trauma	8,298	10,102	11,051	10,940	11,030
Intermittent explosive disorder	15,312	33,355	8,686	48,404	33,148
Academic underachievement	1,588	1,705	1,234	5,980	3,554
Reactive attachment disorder	7,499	6,565	8,672	11,760	6,985
ADD	12,708	11,484	6,390	7,658	5,059
ADHD	5,579	5,231	5,345	6,359	5,861
Intro Procedures on the Larynx	3,676	3,689	2,382	2,108	2,308
Alexia	3,204	712	189	223	
Developmental dyslexia	1,691	1,310	1,412	964	689
Specific reading disorder	1,597	5,593	1,463	960	1,020
Expressive language disorder	4,376	1,969	4,096	1,943	4,681
Language disorder	18,074	2,474	2,515	6,735	2,132
Mild cognitive impairment	1,679	2,097	7,176	5,485	5,582
Toxic encephalopathy	1,341	2,590	88,863	36,921	
Static encephalopathy	5,090	17,944	21,321	2,920	22,166
Microphthalmos NOS	23,946	96,402	20,833	15,975	10,283
Fetal Alcohol Syndrome (EIU)	3,465	2,377	4,845	2,163	9,669
Underweight	5,223	2,948	1,738	2,092	1,828
Lack norm physio dev NOS	74,662	312,012	80,336	78,569	84,524
Failure to thrive in childhood	14,749	12,532	15,159	16,432	44,790
Delayed milestones	14,533	31,810	3,561	11,035	2,858
Short stature	9,358	6,313	9,764	7,189	31,223
Alexia and dyslexia	786	566	3,502	1,433	1,193
Symbolic dysfunction	865	680	610	833	824
Cognitive communication deficit	294	3,889	2,110	451	850
Symptoms involving cognition	9,437	9,932	159,022	88,341	21,189

Figure 2: Distribution of total spending between 2011 and 2015

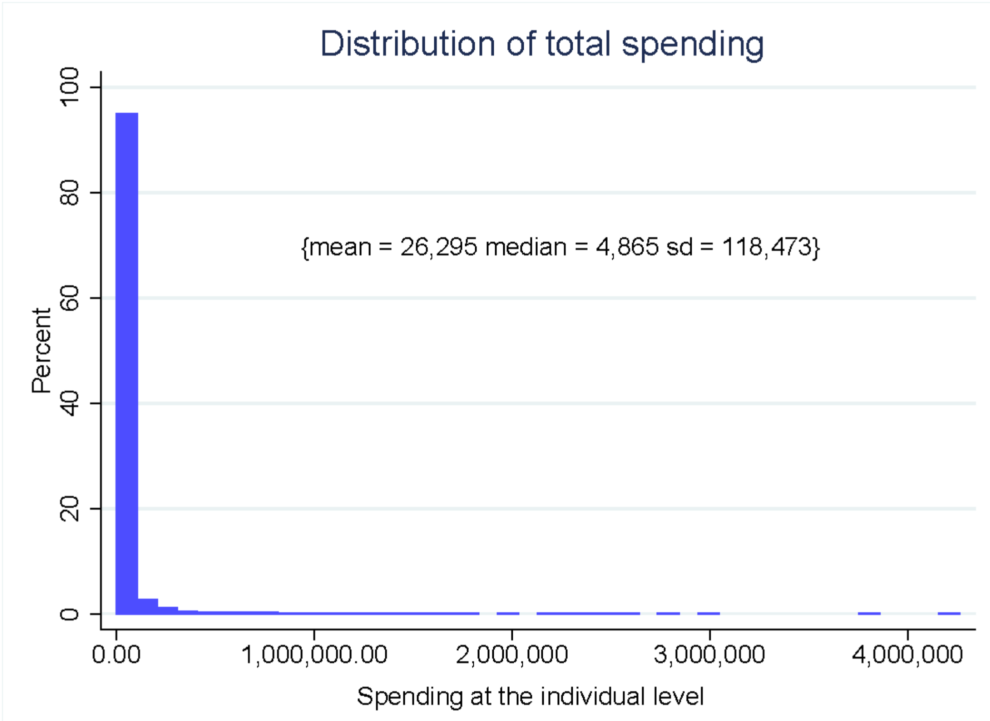
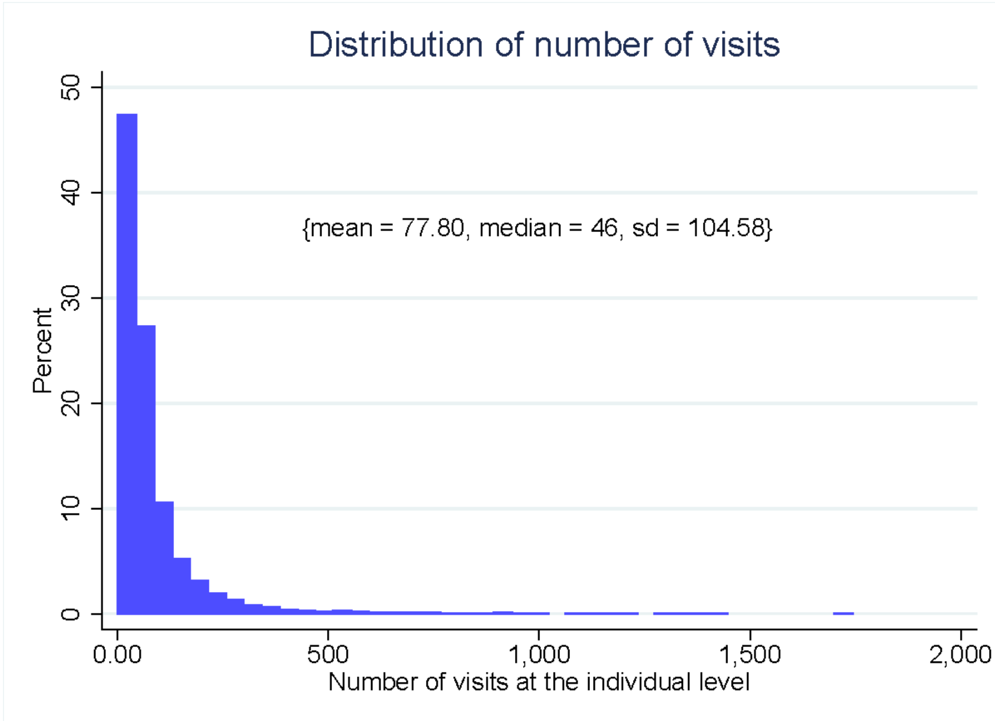


Figure 3: Distribution of total visits



6 Distribution of spending and visits at the individual level

As we have shown above, there is considerable heterogeneity in spending and visits by initial code. This section describes the distribution of spending and visits at the individual level. Figure 2 shows that the average expenditure at the individual level is $26,295 but with a large standard deviation of $118,473 which makes it clear that the data is highly skewed. In fact, at $4,865, the median expenditure is considerably lower than the average. Most of the individuals (75%) had expenditures less than $10,703. This finding is consistent when examining the number of visits, as the average is much higher than the median as can be seen in Figure 3.

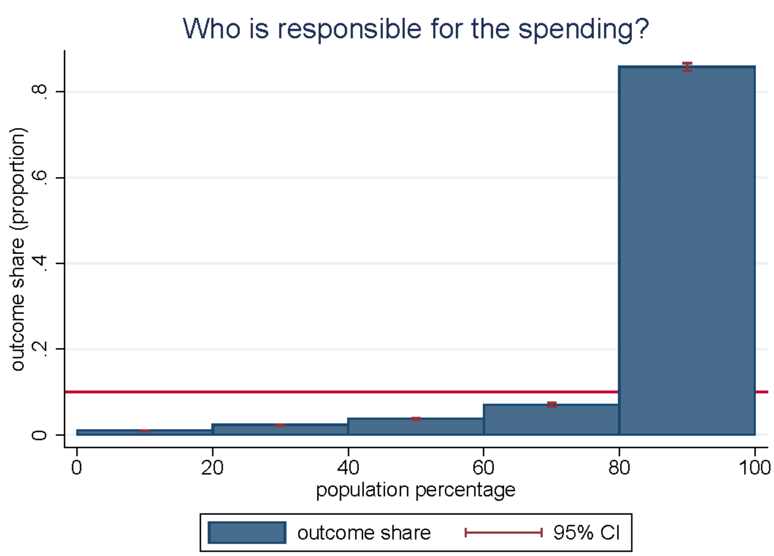
7 Who is responsible for the spending?

This section shows that almost 86% of the spending is attributable to the top 20% individuals. The lowest 20% spenders are responsible for less than 1% of the overall expenditures.

	(1)
Quintiles	Share of total spending
0-20	0.72%***
	(0.00273)
20-40	2.18%***
	(0.000743)
40-60	3.74%***
	(0.001245)
60-80	6.95%***
	(0.00223)
80-100	86.3%***
	(0.00441)
Observations	17,531

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 4: Share of spending by quintile



8 Basic estimation

In this section, we examine the factors that explain the variation in expenditures across individuals. We estimate the basic regression below as a starting point:

$$y_i = \beta_0 + \beta_1 Diag_i + \beta_2 Male + \beta_3 Age + \beta_4 Agesq + \tau_t + \epsilon_i \tag{1}$$

where y_i is the total spending for individual i; $Diag_i$ are the total number of orignial diagnoses for individual i; $Male$ is a dummy variable indicating if the patient is male or female, Age and *Age squared* examine the nonlinear relationship between age and expenditures. Lastly, τ captures time invariant effects, and ϵ_i is the model error. The β_{1-4} and τ coefficients are parameters to be estimated. The coefficient of interest, β_1, is the estimated effect of an additional diagnosis on expenditures.

VARIABLES	(1) Total spending
Number of FASD-related diagnoses	44,825***
	(1,534)
Male	-3,774.11***
	(1,889)
Age at FASD-related diagnosis	-3,381,79***
	(578.2)
Age square	225.21***
	(36.59)
2012.year	4,830.32*
	(2,814)
2013.year	13,197***
	(2,843)
2014.year	8,402***
	(2,859)
2015.year	12,113***
	(2,865)
Constant	-37,161***
	(10,341)
Race (categorical)	YES
Observations	16,753
R-squared	0.056

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

From the regression, we can conclude that each additional FASD-related diagnosis is associated with an additional $44,825 in expenditures. It is important to note that the majority of individuals in our sample have only 1 FASD-related diagnosis. Additionally, we can see that, holding all other variables constant, being a male is associated with fewer expenditures and a diagnosis at an earlier age is also associated with less spending.

9 Births post 2010

In this section, we focus on individuals born post 2010. Since the available data begins in 2011, examination of these individuals allows us to observe the universe of their visits. This simplifies our analysis as we do not have any omitted visits before the start of our data.

When we restrict our data to just those individuals, we are left with 3,896 individuals with a total of 457,820 observations. Of the individuals, 57.2% are male and 42.8% are female. For this subsample, the first 1-5 years of life are captured in the data and, over that time, these children have an average of 60 visits per year with an average visit cost of $410.60.

Table 11: Number of individuals by race and gender

Race	Female	Male	Total
Native Hawaiian	254	365	619
Filipino	284	386	670
Pacific Islander	139	202	341
Other Asian	188	295	483
White	294	380	674
Other	337	418	755
Unknown	162	183	345
Total	1,658	2,229	3,887

In Table 12, we show the distribution of the births across the five years for which we have data. We observe the children who were born in 2011 years for four years, those in 2012 for 3 years, and so on.

Table 12: Number of children by birth year

Birth year	Number of children
2011	1,214
2012	1,077
2013	812
2014	544
2015	249
Total	3,896

For an individual to be included in our dataset, they have to meet an inclusion criteria of having at least one FASD-related visit. The table below shows the age at which the children first had an FASD-related visit. We can see that, in this subsample of individuals born after 2010, 35.9% of the individuals had their first diagnosis before turning 1 and 81.7% of our sample had an FASD-related visit by the age of 3.

9.1 When does the initial diagnosis happen?

We examine the number of FASD-related conditions for the children in our subsample in Table 14. We find that the majority (82.4%) have only one FASD-related condition; less than 0.6% have more than 5 conditions. We next examine the frequency of overall and FASD-specific visits. We note from the table that the share of visits specifically associated with FASD-related conditions differ by age and range between 7.1% and 12.5%.

Table 13: Age of initial diagnosis

Year	Number of children
0	1,402
1	962
2	820
3	553
4	159
Total	3,896

Table 14: Inclusion criteria

Number of conditions	Number of children
1	3,212
2	492
3	137
4	33
5	11
6	11
Total	3,896

9.2 Frequency of visits

Table 15: Visits and expenditures by age

Age	M visits	M FASD-related visits	M charges	M FASD-related charges
0	21.37	2.42	395.60	77.71
1	20.16	4.24	98.83	97.31
2	16.53	5.49	68.19	50.95
3	14.82	5.90	66.32	56.92
4	14.96	6.01	58.97	43.80
Overall	18.47	4.15	166.97	73.27

9.3 Visits and spending by year at the individual level

In this section, we analyze the information at the individual level by averaging the spending by year. Therefore, we only leave one observation per year per individual.

Table 16: Total and FASD expenditures by year

Year	*M* per visit	*SD* per visit	*M* total	*SD* total
Expenditures by year at the individual level				
2011	227.87	503.04	15,583.42	61,772.4
2012	191.74	525.33	13,697	103,124
2013	181.83	738.98	14,435.06	79,547.01
2014	172.32	708.58	15,055.51	78,044.97
2015	114.26	403.26	12,023.13	86,807.3
Average	166.97	604.41	10,671.41	73,873.39
FASD expenditures by year at the individual level				
2011	79.09	223.00	172.47	380.00
2012	79.14	456.12	346.88	1,732.10
2013	59.30	107.15	356.98	2,647.35
2014	73.95	438.26	774.83	12,616.75
2015	79.90	1,022.43	415.51	2,662
Average	73.27	597.15	471.97	6,952.01

Table 17: Overall and FASD-related visits by year

Year	*M* visits	*SD* visits	*M* FASD visits	*SD* FASD visits
2011	17.53	24.10	4.87	9.05
2012	17.72	24.67	4.37	8.24
2013	18.55	25.32	4.22	7.73
2014	18.96	28.56	4.29	8.37
2015	18.67	30.90	4.28	8.54
Average	18.47	27.56	4.28	8.27

Table 18: Overall expenditures by year

Year	Total ($)	Total FASD ($)
2011	16,611,927	72,096
2012	28,614,058	280,287
2013	41,197,672	431,594
2014	50,285,388	1,124,282
2015	40,361,660	545,985
Total	177,070,705	2,454,244

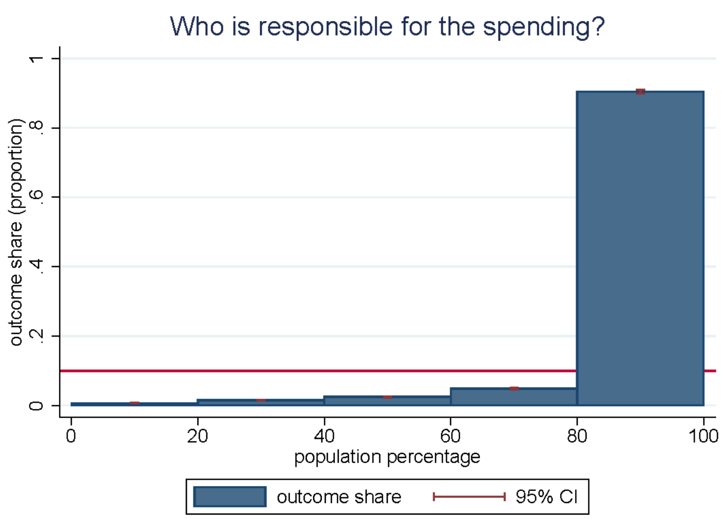
10 Who is responsible for the spending among the children born post 2010?

This section shows that almost 90% of the spending is attributable to top 20% of individuals. The lowest 20% of individuals (by cost) are responsible for less than 1% of the overall expenditures.

VARIABLES	(1) Total spending
0-20	0.68%***
	(0.0002)
20-40	1.54%***
	(0.00049)
40-60	2.48%***
	(0.00078)
60-80	4.87%***
	(0.00147)
80-100	90.04%***
	(0.00289)
Observations	3,896

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 5: Figure 4: Who is responsible for the spending?



10.1 Are the results any different for this subsample?

The results for the children born post 2010 are very similar to our main analysis. This consistency gives us confidence in our main sample.

11 Limitations

Findings of these analyses must be interpreted in context of the study's limitations. First, the data available include patients who met inclusion criteria within seven years. Therefore, other patients who had FASD-related diagnoses outside of the seven year window are not included. Additionally, the data are for visits during a five year period and therefore do not capture the entire adolescent period from birth through age 18 for any cohort of patients.

A second limitation is related to the challenges of diagnosing FASDs. As an umbrella diagnosis, FASDs includes many conditions and the data available are based on ICD codes that relate to those specific conditions. However, these conditions are not always FASD and there is not a unique ICD code for the conditions when they represent FASD. Therefore, it is likely that not all of the patients included in our analyses have a FASD. Approximately 9% of Hawaii's childhood Medicaid population is included in our sample and 5% is a conservative estimate of FASD prevalence. Therefore, we are likely slightly overestimating the visits and expenditures that are truly associated with FASDs. However, FASDs tend to be complex disorders, which suggests that the more expensive cases may be more likely to be attributable to FASDs.

12 What does FASD prevention cost?

FASDs are preventable if a developing fetus is not exposed to alcohol. Alcohol SBI is an evidence-based approach to reduce risky alcohol use and prevent consequences of risky alcohol use, including FASDs.

As 45.2% of Hawaii births are unintended (Centers for Disease Control and Prevention, 2011), prevention efforts should focus on all women who could become pregnant, not just those are trying to become pregnant. Hawaii has 261,665 females ages 15-44 (U.S. Census Bureau, 2010). Of those, 18%, or 47,100 people, are covered by Medicaid (Guttmacher, 2018). Prevention for FASDs could focus on women who drink alcohol, which is 41% of women in Hawaii (BRFSS, 2011-2014), or 19,311 women of childbearing age on Medicaid. Hawaii Medicaid reimbursement rates for alcohol SBI are $24.04 (15-30 minutes) and $46.92 (more than 30 minutes). Even if every woman of childbearing age who drinks alcohol is given a brief intervention, it would cost $464,236. This is an overestimate of costs of prevention, as most women who consume alcohol do not require a 15-minute brief intervention and instead could be educated about the risks of alcohol during pregnancy with a briefer amount of discussion and education.

13 Conclusion

We found that, on average, FASD-related visits cost Medicaid $6 million/year in Hawaii. Some, but not all, of these costs can be prevented by reducing alcohol-exposed pregnancies. Alcohol SBI can be used systematically and cost-effectively to prevent FASDs as well as other consequences of risky alcohol use. Alcohol SBI consultations are currently reimbursed only when they are at least 15 minutes, but it typically takes only 3-4 minutes. Medicaid in Hawaii and other states could promote prevention of FASDs through improved reimbursement rates and reimbursement for briefer (less than 15 minute) interventions. Even if Medicaid incurred additional costs for alcohol SBI, such prevention activities are far less expensive than treating alcohol consequences including FASDs.

References

Babor, T. F., B. G. McRee, P. A. Kassebaum, P. L. Grimaldi, K. Ahmed, and J. Bray (2007). Screening, Brief Intervention, and Referral to Treatment (SBIRT): toward a public health approach to the management of substance abuse. *Substance abuse 28*(3), 7–30.

Chasnoff, I. J., A. M. Wells, and L. King (2015, 2). Misdiagnosis and Missed Diagnoses in Foster and Adopted Children With Prenatal Alcohol Exposure. *PEDIATRICS 135*(2), 264–270.

Désy, P. M. and C. Perhats (2008, 2). Alcohol Screening, Brief Intervention, and Referral in the Emergency Department: An Implementation Study. *Journal of Emergency Nursing 34*(1), 11–19.

Hong, M. and R. S. Krauss (2017, 4). Ethanol itself is a holoprosencephaly-inducing teratogen. *PLoS ONE 12*(4).

Jirikowic, T., J. Gelo, and S. Astley (2010, 10). Children and youth with fetal alcohol spectrum disorders: Summary of intervention recommendations after clinical diagnosis. *Intellectual and Developmental Disabilities 48*(5), 330–344.

Lange, S., C. Probst, G. Gmel, J. Rehm, L. Burd, and S. Popova (2017, 10). Global prevalence of fetal alcohol spectrum disorder among children and youth: A systematic review and meta-analysis. *JAMA Pediatrics 171*(10), 948–956.

Lewis, V. A., C. H. Colla, K. Tierney, A. D. van Citters, E. S. Fisher, and E. Meara (2014). Few ACOs pursue innovative models that integrate care for mental illness and substance abuse with primary care. *Health Affairs 33*(10), 1808–1816.

May, P. A., C. D. Chambers, W. O. Kalberg, J. Zellner, H. Feldman, D. Buckley, D. Kopald, J. M. Hasken, R. Xu, G. Honerkamp-Smith, H. Taras, M. A. Manning, L. K. Robinson, M. P. Adam, O. Abdul-Rahman, K. Vaux, T. Jewett, A. J. Elliott, J. A. Kable, N. Akshoomoff, F. Daniel, J. A. Arroyo, D. Hereld, E. P. Riley, M. E. Charness, C. D. Coles, K. R. Warren, K. L. Jones, and H. E. Hoyme (2018, 2). Prevalence of fetal alcohol spectrum disorders in 4 US communities. *JAMA - Journal of the American Medical Association 319*(5), 474–482.

Onoye, J. M. and M. D. Thompson (2017, 5). Challenges and Progress in Building a Comprehensive Statewide System for Fetal Alcohol Spectrum Disorders Prevention in Hawaii. *Maternal and Child Health Journal 21*(5), 1002–1009.

Popova, S., S. Lange, C. Probst, G. Gmel, and J. Rehm (2017, 3). Estimation of national, regional, and global prevalence of alcohol use during pregnancy and fetal alcohol syndrome: a systematic review and meta-analysis. *The Lancet Global Health 5*(3), e290–e299.

Popova, S., S. Lange, K. Shield, A. Mihic, A. E. Chudley, R. A. Mukherjee, D. Bekmuradov, and J. Rehm (2016, 3). Comorbidity of fetal alcohol spectrum disorder: A systematic review and meta-analysis. *The Lancet 387*(10022), 978–987.

Rieckmann, T., S. Renfro, D. McCarty, R. Baker, and K. J. McConnell (2018, 6). Quality Metrics and Systems Transformation: Are We Advancing Alcohol and Drug Screening in Primary Care? *Health Services Research 53*(3), 1702–1726.